X-ray Schlieren Experiments at SPring-8

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It has been reported that using a parallel x-ray beam from a third-generation storage ring[1] or a point-focus laboratory x-ray source[2] an edge-enhanced x-ray image can be obtained by simply recording projection with a long specimen-to-detector distance. This is sometimes referred to as a "phase-enhanced" image. We examined the origin of this enhancing effect by scanning an object (glass capillary) with a narrow x-ray beam. The experiment was done at the beamline BL47XU of SPring-8. An x-ray beam of 28.8 keV from a Si(111) double-monochromator was used. The glass capillary was set horizontally and a slit with a vertical width of about 0.01 mm was placed just in front of the capillary. The specimen-to-detector distance was 4.7 m. The detector was a cooled CCD which viewed a fluorescent screen through a lens system. The spatial resolution of the detector was 0.02 mm. The image of the glass capillary without the slit showed light and dark fringes at its outer and inner edges. When it was scanned vertically with the x-ray beam through the slit, the transmitted beam was clearly deviated from the straight path and the image of the glass capillary could be reconstructed by simply summing the beam profiles at different positions, showing that the main cause of the edge-enhancement was refraction. Thus we conclude that this imaging technique should be called "x-ray refraction contrast imaging" or "x-ray Schlieren imaging." In order to test the possibility of medical application of the Schlieren imaging, we recorded an image of a nude mouse using a similar setup. A nude mouse was preferred to an ordinary mouse because hairs tend to complicate images. Images with a contrast different from that in a typical contact transmission image were obtained. The contrast is most enhanced at an interface between two materials with different refractive indices. Thus, alveoli in lung were visualized with an enhanced contrast.

This may be a useful method to diagnose various diseases of the lungs.

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[1]Snigirev et al., Rev. Sci. Instrum. 66:5486-5492, 1995.
[2]Wilkins et al., Nature 384:335-338, 1996.